Students' Mathematical Literacy Based on Self-Efficacy By Discovery Learning With Higher Order Thinking Skills-Oriented

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Article Info

Abstract

Purposes of this research are to describe the quality of Discovery Learning with higher order thinking skills-oriented to students' mathematical literacy, to describe students' mathematical literacy based on their self-efficacy, and to analyze the influence of self-efficacy towards students' mathematical literacy. This research uses mixed method by concurrent embedded design type. The subjects are the students of first grade of SMA Negeri 1 Slawi. Based on the three stages of learning quality, Discovery Learning with higher order thinking skills-oriented is qualified to student's mathematical literacy. In the case of aspect of the process of mathematical literacy, students with high self-efficacy are able to master the four aspects excellently, and they able to master the other three aspects well with some mistakes. Students with medium self-efficacy are mastering one aspect well, and cannot mastering the other six aspects well. Students with low self-efficacy cannot master five aspects maximally, and cannot master two other aspects. Mathematical literacy are influenced by self-efficacy about 34.6%.

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INTRODUCTION

Mathematics is one of the sciences that be taught and obtained by students through formal education. Junaedi & Asikin (2012) explained that mathematics learning needs to be designed so that it can encourage students to have mathematical skills, such as comprehension, communication, connection, reasoning and problem solving. The abilities are required for students to acquire, manage and utilize information to survive in an ever-changing, uncertain, and competitive state. This is a basic idea of mathematical literacy.

According to OECD (2016), mathematical literacy is defined as students' capacity to formulate, employ and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena. It assists individuals in recognizing the role that mathematics plays in the world and to make the well-founded judgments and decisions needed by constructive, engaged and reflective citizens. The definition can be analyzed by three aspects; those are process, content, and context. In process aspect, there are seven basic abilities; they are *communication, mathematising, representation, reasoning and argument, devising strategies for solving problems, using symbolic, formal and technical language and operation,* and *using mathematics tools.*

Mathematical literacy abilities are needed by students to realize what mathematical concepts are relevant to the problem facing. Wardono & Mariani (2014) recommended teachers to use PISA-oriented assessments in classroom mathematics learning, so that students' mathematical literacy can be honed, and Indonesia's ranking in the next PISA test can be improved.

Waluya (2012) stated that the success of a person is not determined solely by knowledge and technical skills (hard skills), but rather by the ability to manage themselves and others (soft skills). Students' soft skills of self-confidence to express ideas also contribute to the success of students' problem solving. Bandura (1994) stated that self-efficacy is defined as one's belief in one's own ability to produce a level of achievement that affects events in real life. Sunawan, Sugiharti, and Anii (2017) suggested that students with high levels of self-efficacy tend to enjoy learning mathematics, and students with low self-efficacy tend to have high emotional anger, anxiety, and boredom. Self-efficacy students will be more easily developed when teachers use learning that developing student self-concept. Bindak and Ozgen (2011) mentioned that self-efficacy for mathematical literacy in students can be changed and improved by using appropriate learning strategies, such as helping students build learning goals, ensuring students to work hard, and always providing feedback on student responses.

Rochmad and Masrukan (2016) stated that the main support of the success of learning is done in the classroom because the teacher uses the appropriate learning model, varies, good teaching and uses good questions. One of the learning model that can improve the ability of mathematical thinking that allows students to learn optimally and support the mathematical literacy is Discovery Learning. Discovery Learning is a learning that can be facilitated with specific teaching methods and guided learning strategies.

In addition to active and creative learning, thinking skills are also needed to developing mathematical literacy and self-efficacy. The pattern of mathematical thinking on activity is divided to two based on the depth of mathematical activities, namely low-order thinking and higher order thinking. Rajendran (2008) stated that higher order thinking is defined as the development of thinking against new challenges. Meanwhile, lower order thinking represents routine application, mechanism and limited use of thought.

In this study, higher order thinking skills developed are based on thinking process variables as described by King et al. (1998), these are: (1) context, (2) metacognition, (3) procedural knowledge, (4) comprehension, (5) creativity, (6) insight, (7) intelligence, (8) problem solving, and (9) critical thinking.

The problems are (1) how the quality of Discovery Learning with higher order thinking skills-oriented toward students' mathematical literacy, (2) how about students' mathematical literacy based on their self-efficacy, and (3) how about the influence of self-efficacy to students' mathematical literacy.

This research was done to describe the quality of Discovery Learning with higher order thinking skills-oriented toward students' mathematical literacy, analyze students' mathematical literacy based on their self-efficacy, and

analyze the effect of self-efficacy to students' mathematical literacy. The learning quality is measured using three stages, learning process planning, learning process implementing, and learning outcomes assessment.

METHODS

This study uses mixed method by concurrent embedded design type, where the quantitative design used is quasi experiment. It begins with observing as preliminary study, then collecting quantitative and qualitative data, and followed by analyzing and data interpretation.

The research was conducted in SMA Negeri 1 Slawi where the population is the students of grade X of academic year 2017/2018. The subjects are 32 students for class used Discovery Learning with higher order thinking skills-oriented, and 34 students for class used Discovery Learning.

The data are obtained from students' results of mathematical literacy test, self-efficacy questionnaire, interview outcome of the test results, and observation sheets of teacher activity during the learning process. The test grade are used as a source of quantitative data, while the sources for qualitative are student's test answer sheets, self-efficacy questionnaire outcomes, and interview outcomes of mathematical literacy. Quantitative data analyses are calculated using normality, homogeneity, proportionality, average mastery, proportion comparison, average comparison, self-efficacy improvement, and influence test. While qualitative data analyses done using validation data, making verbal data transcript, data reduction, data presentation, and data verification.

RESULTS AND DISCUSSION

The average score of learning instrument validation score is 4.51, and the average of research instrument validation score is 4.63. The following table describes validation scores for each learning and research instrument.

Table 1. Validation Score

Instrument	Score	Category
Syllabus	4.52	Very Good
Lesson Plan	4.53	Very Good
Text Book	4.53	Very Good
Worksheet	4.47	Very Good
Student *Self-Efficacy* Questionnaire	4.75	Very Good
Student Mathematics *Self-Efficacy* Questionnaire	4.58	Very Good
Literacy Mathematics Test	4.5	Very Good
Interview Manual	4.5	Very Good
Learning Implementation Observation Sheet	4.67	Very Good
Students Response Questionnaire	4.75	Very Good

Based on the validation result, it can be said that the learning and research instrument are included to very good category and feasible to use.

Self-efficacy questionnaire result the percentage of high self-efficacy, medium self-efficacy, and low self-efficacy students are 12.5%, 68.75%, and 18.75% respectively.

For the implementation stage of the learning process, the learning quality is measured by the observation of the implementation of learning and provided a questionnaire of student responses. By the observation, the average score of the teacher managing the learning is 4,225 or 84,5%. It means the learning included to very good category, and 84,5% appropriate with the lesson plan. Based on student response data analysis, the average score obtained is 2.94 or 73.36%. It means the students assessed the learning that is implemented is 73.36% good.

The learning process integrates higher order thinking skills, so that teachers facilitate students to become a thinkers and problem solvers by providing problems that enable students to use their high-level thinking skills. Every problem given in a specific case and have a sub-solution, such as problem identification, hypotheses, given information, illustration, material concept discussion, question solution, conclusion, and material summary. Those were done such that students can use their higher order thinking skills to develop their mathematics literacy. Picture below is a sample of students' discussion result for a problem in worksheet based on its sub-solution.
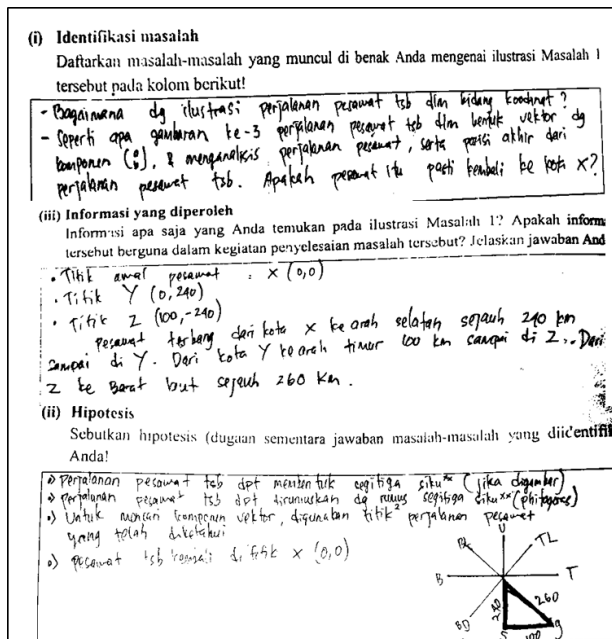
Figure 1. Sample of Student's Discussion Result

The students state problem asked appear in a given case in the worksheet, they find information from the illustration, and then they make the hypotheses. Problems and hypotheses can differ between each groups, because the problems that arise in the discussion are different.

In identifying the problems and hypotheses, students need higher order thinking skills, namely critical thinking and metacognition, because students need to plan, monitor understanding, and evaluate problems. This is in accordance with the notion of metacognition thinking according to Schraw and Robinson (2011), ie students involve active control of the cognitive process in learning. In addition, students also need to understand and express the meaning of the rules, situations, and data of the existing problems. This also corresponds to the interpretation indicator in critical thinking expressed by Facione (2011).

At the learning result assessment stage, it is found that the mathematical literacy test result is normal and homogeneous distribution. In the calculation of the completeness and comparison test, the significant level or α used is 0.05. The obtained completeness proportion is 78.13%, with the z value being 0.40825 and $z_{\frac{1}{2}(1-\alpha)}$ was 1.96, so that $-z_{\frac{1}{2}(1-\alpha)} < z < z_{\frac{1}{2}(1-\alpha)}$, which means the proportion of completeness reach 75%. It is obtained the proportion of control class is 38.24%. Based on the result of comparison test of proportion, the value of z

is 3,277 and the value of $z_{(0,5-\alpha)}$ is 1,64, so $z \geq z_{(0,5-\alpha)}$, which means the proportion of students who get learning materials using Discovery Learning with higher order thinking skills-oriented is more than the proportion of mastery of class students who acquire learning materials using Discovery Learning.

The average value obtained is 79.58, with t value is 1.7192, and $t_{1-\alpha),dk}$ is 1.694, so $t > t_{(1-\alpha),dk}$, which means the average ability of students' mathematical literacy of the classes that received learning materials using Discovery Learning with higher order thinking skills-oriented more than 76. The average of control class is 72.69. Based on the average comparative test analysis, t value is 2.1449 and $t_{(1-\alpha),dk}$ is 1.669, so $t > t_{(1-\alpha),dk}$, which means the average of students' who acquired learning materials using Discovery Learning with higher order thinking skills-oriented more than the class that acquired learning materials using Discovery Learning.

Based on normalized gain test, students' self-efficacy improved with low criterion, that is 43.75% of students experienced moderate self-efficacy improvement, and 53.125% of students experienced low self-efficacy improvement.

The test showed the average score for students with high self-efficacy, medium self-efficacy, and low self-efficacy is 93.75, 81.41, and 63.39 respectively.

Based on regression test, self-efficacy has a positive influence with the students' mathematical literacy, although that is not a dominant effect, only 34.6%. There is 65.4% ability influenced by other factors such as social, psychological, or physical condition of students when the test was conducted.

In the aspect of communication, students with high self-efficacy are able to state information that is known, the problem asked, and the idea of the concept of problem solving.
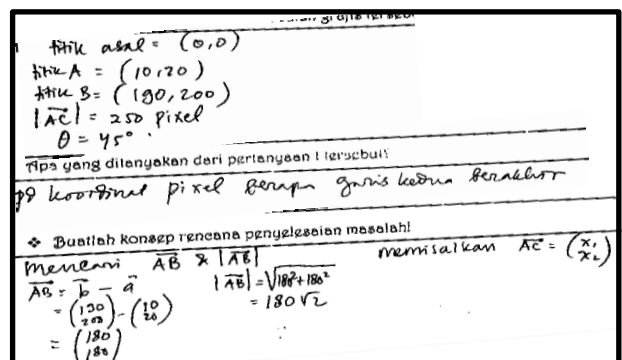

Figure 2. Sample of High Self-Efficacy Student's Work Aspects of Communication

The results indicate that the student can state the information, the problem asked, and the idea of the concept of problem solving correctly, precisely, and completely. It can be said that the students with high self-efficacy have excellent communication aspect.

Students with medium self-efficacy are also having good communication, although they have not been able to solve problems according to the concept. Meanwhile, students with low self-efficacy are only able to communicate a few idea of the concept of completion according to the problem presented, even though the idea is not appropriate to the case given.

In the aspect of mathematising, students with high self-efficacy can mention the information known and asked correctly and completely, and make the mathematical form of the case submitted correctly. Students with medium self-efficacy are also able to change the problem to the mathematical form correctly, as well as with the proper definition, but incomplete.

Figure 3. Sample of Medium Self-Efficacy Student's Work Mathematising Aspects

The result showed that students can make the mathematical form of the case submitted correctly and incompletely, because the answers are not explained. Students with low self-efficacy also cannot master the aspect of mathematising, because they not able to create a mathematical model precisely and completely.

In the aspect of reasoning and argument, students with high self-efficacy can solve the problem according to the concept that has been planned correctly and completely, then make final conclusions and explain in detail about the reason or basis of conclusion of the settlement made.

Students with self-efficacy are able to provide the right conclusions as well as the reason or way of working properly and completely.

Figure 4. Sample of Medium Self-Efficacy Student's Work Reasoning and Argument Aspect

The work showed that the student is able to solve the problem along with the conclusion. However, in the final analysis, students are still less precise in determining the vectors used due to the measurement of unsuitable angular directions. Students with low self-efficacy also cannot master the aspect of reasoning and argument, because they only write the he half conclusion of their answer only.

In the aspect of devising strategies for solving problems, students with high and medium self-efficacy are able to make a settlement of the concept or problem-solving strategy that has been made first to find the right solution. Students with low self-efficacy are also able to provide correct completion steps but with incorrect calculation results and do not interpret the strategies used to solve the problem.

Figure 5. Sample of Low Self-Efficacy Student's Work for Devising Strategies for Solving Problems Aspect

The student's work above indicated that he has been able to make the solution concept although he was not interpret it and problem solving.

In the aspect of representation, students with high and medium self-efficacy are able to present the

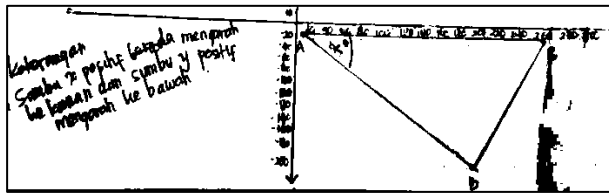problem by making the image and interpreting it well, although there is still some solution errors

Figure 6. Sample of Medium Self-Efficacy Student's Work for Representation Aspect

Medium self-efficacy students are being able to represent the problem by drawing a picture and describing it, but it is less appropriate with the case presented. Students with low self-efficacy cannot master the aspect of representation, because students have not been able to make representations of cases in the picture.

In terms of using symbolic, formal and technical language and operation, students with high and medium self-efficacy are able to use symbols, formal language and techniques, and operations to formulate, solve or interpret problems well, despite the inconsistencies in symbolic writing.
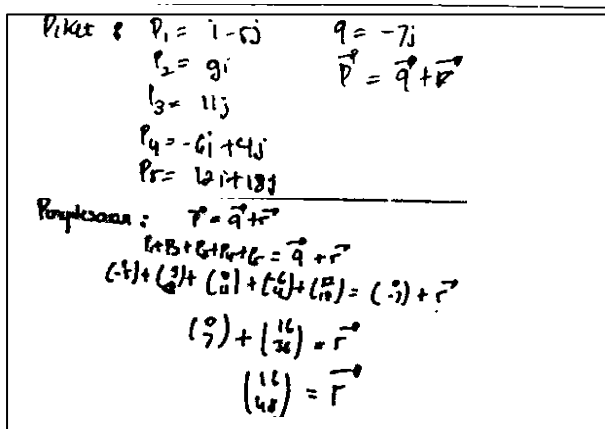

Figure 7. Sample Student Results High Self-Efficacy Aspects Using Symbolic, Formal and Technical Language and Operation

The students are able to solve problems with the correct symbols and operations. However, the student occasionally made some mistakes in writing vector symbols that should have an arrow on top of the variable or written bold to make a difference with scalar writing.

Students with low self-efficacy also have not been able to master the aspects of using symbolic, formal and technical language and operation, because

there is a lot of inaccuracy of vector symbols, and less able to create, understand, and explain mathematical symbols in accordance with the case of problems.

For using mathematics tools aspect, students with high and medium self-efficacy can use mathematical tools such as measurements, rulings, and others well, precisely, and neatly.
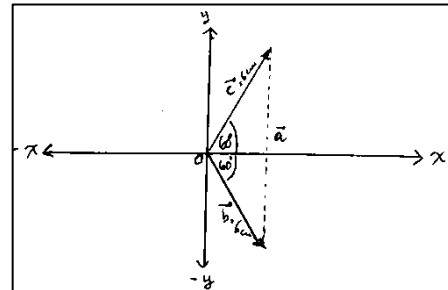

Figure 7. Sample Student Results Self-Efficacy High Aspects Using Mathematics Tools

The result shows that students can use mathematical tools to draw vectors with ruler, protractor, and tidy even though they have not depicted the scale used. While students with low self-efficacy are less skilled in using the tools such as measurements, rulers, and so on, because there are some illustrations that do not fit the description of the image.

From the results of mathematical literacy test and interviews to the subjects, it can be concluded that students with high self-efficacy have excellent mathematical literacy skills, students with medium self-efficacy are having sufficient mathematical literacy skills, and students with low self-efficacy are not able mastering aspects of mathematical literacy correctly, precisely, and completely. Zimmerman (2000) stated that self-efficacy assessments can lead to the assessment of the student before performing certain activities. The position of this self-efficacy assessment plays an important role in the students' academic motivation.

Mathematical literacy shown by students with high self-efficacy is based on the students' very strong desire to master mathematics well. Schunk & Pajares (2001) stated that students with high efficacy will complete learning tasks well, participate in learning more preparedly, work hard, survive longer when they encounter difficulties, and are able to achieve higher achievement. Ahmad and Safaria (2013) also mentioned that students with high self-efficacy would have a higher goal than students with low self-

efficacy. They also believe that they can solve problems and get excellent grades on math tests.

Mathematical literacy shown by students with medium self-efficacy based on their beliefs to master mathematics well. They try to communicate with friends to find the best solution of the mathematical problem they face, although sometimes they avoid doing school work. They can enough motivate themself to learn mathematics, but they often get nervous and cannot concentrated if they meet a trouble in solving the problems.

Students with low self-efficacy have a tendency to give up easily when they face difficult problems. Sometimes students want to do school work, sometimes they avoid it, and feel hopeless. According to Schunk and Pajares (2001), low-efficacy students tend to choose lesson tasks and activities related to the material they like and feel easy for them.

CONCLUSIONS

Discovery Learning with higher order thinking skills-oriented is qualified for students' mathematical literacy. This is shown by the assessment of the three learning stages, these are learning process planning stage, learning process implementation stage, and the assessment of learning outcomes.

Students' mathematical literacy can be determined based on their self-efficacy. They who have high self-efficacy are able to master the four process aspects of mathematical literacy excellently; these are communication, mathematising, reasoning and argument, devising strategies for solving problems. For the other three aspects, studentsthey are also able to master it well but there are still a few mistakes. Students who have medium self-efficacy are capable of having one aspect very well and maximally, that is devising strategies for solving problems, and for the other six aspects of mathematical literacy can be mastered even though not optimally. While students who have low self-efficacy has not been able to master aspects of mathematical literacy well. Five aspects can be mastered by students sufficiently, and for two other aspects, these are communication and using symbolic, formal and technical language and operation, students tend not to master it.

Self-efficacy also had a positive effect on students' mathematical literacy. It has 34.6% affected well on describing mathematical literacy. Therefore, assessment and development of self-efficacy is helpful when teachers want to know and cultivate students' mathematical literacy in the classroom.

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